

Our File No.: 042390.P6785
Express Mail No.: EL236787001US

UNITED STATES PATENT APPLICATION

FOR

HIGH PERFORMANCE THERMAL INTERFACE CURING PROCESS FOR
ORGANIC FLIP CHIP PACKAGES

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BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

5 The present invention relates to a process for curing a thermal epoxy that couples an integrated circuit to a thermal element.

2. BACKGROUND INFORMATION

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Integrated circuits can be assembled into packages that are soldered to a printed circuit board. The integrated circuit is typically mounted to a substrate and enclosed by an encapsulant. Integrated circuits
15 generate heat that must be removed from the package. Some integrated circuit packages incorporate thermal elements such as heat spreader to improve the thermal performance of the package. The heat spreader may be coupled to a surface of the integrated circuit by a
20 thermal grease or a thermal epoxy.

The thermal epoxy may be cured in an oven that heats the entire package. The coefficient of thermal expansion of the substrate is typically different than the expansion coefficient of the integrated circuit and the
25 thermal element. When the thermal epoxy is heated in the oven the different coefficient of expansions may create a warpage in the package. The warpage may induce a pumping

action of the thermal epoxy so that epoxy flows out of the integrated circuit/thermal element interface. This pumping event may create an air gap between the integrated circuit and the thermal element. Air has a low coefficient of thermal conductivity. The existence of air increases the thermal impedance of the package and the junction temperatures of the integrated circuit. It would be desirable to provide a process that cures the thermal epoxy without heating the other elements of the package.

SUMMARY OF THE INVENTION

One embodiment of the present invention is an integrated circuit package which has a thermal epoxy that
5 can be attached to an integrated circuit and a thermal element. The thermal epoxy can be cured with energy at a microwave frequency.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a cross-sectional view of an embodiment
of an integrated circuit package of the present
5 invention;

Figures 2a-b show a process for assembling a thermal
epoxy within the integrated circuit package;

Figures 3a-b show an alternate process for assembling
the thermal epoxy within the package.

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DETAILED DESCRIPTION

Referring to the drawings more particularly by reference numbers, Figure 1 shows an embodiment of an
5 integrated circuit package 10 of the present invention. The package 10 may include an integrated circuit 12 that is mounted to a substrate 14. The integrated circuit 12 may be mounted to the substrate 14 with a plurality of solder bumps 16 in a process commonly referred to as
10 controlled collapsed chip connection (C4). The package 10 may further have an underfill material 18 attached to the integrated circuit 12 and the substrate 14 to improve the structural integrity of the solder bumps 16.

The package 10 may have a plurality of solder balls
15 20 attached to the substrate 14 in a ball grid array (BGA) pattern. The solder balls 20 may be reflowed to attach the package 10 to a printed circuit board (not shown) such as the motherboard of a computer. The substrate 14 may contain routing traces, power/ground
20 planes, vias, etc. that electrically connect the solder bumps 16 to the solder balls 20. Although solder balls 20 are shown and described, it is to be understood that the package 10 may have other types of contacts such as pins.

25 The package 10 may have a thermal epoxy 22 that is attached to a thermal element 24 and the integrated circuit 12. The thermal element 24 may be a heat

spreader that is constructed from a thermally conductive material such as copper or aluminum. The thermal epoxy 22 may be an epoxy resin that contains a thermally conductive filler such as carbon particles. The thermal
5 epoxy 22 provides a thermal path from the integrated circuit 12 to the thermal element 24. The integrated circuit 12 may be enclosed by an encapsulant 26.

Figures 2a and 2b show a method for constructing the package 10. The integrated circuit 12 is typically
10 mounted to the substrate 14 by the solder bumps 16 and underfill material 18. As shown in Fig. 2a an uncured thermal epoxy 22 is applied to the top surface of the integrated circuit 12. By way of example, the uncured epoxy 22 may be applied with a screening process that
15 utilizes a template (not shown).

As shown in Fig. 2b the thermal element 24 is placed
onto the thermal epoxy 22 and the epoxy 22 is cured by a microwave generator 28. The microwave generator 28 generates energy at a microwave frequency that is
20 directed into the thermal epoxy 22. The microwave frequency can be selected to cure the thermal epoxy 22 without damaging the integrated circuit 12 or heating the other components of the package 10. Not heating the other package components eliminates package warpage and
25 epoxy pumping that can create air gaps and voids in the integrated circuit/thermal element interface. By way of example, the microwave energy may have a frequency

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Between _____ and _____ megahertz. After the thermal epoxy 22 is cured the encapsulant 26 can be formed into the package with an injection mold process. The solder balls 20 can then be attached to the substrate 14 to
5 complete the assembly. It may be desirable to bake the substrate 14 before curing the thermal epoxy 22 to insure that the curing process does not release water from the substrate material.

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10 Figures 3a and 3b show an alternate method for assembling the thermal epoxy 22, wherein the epoxy 22 is applied to the thermal element 24 instead of the integrated circuit 12 before being cured by the microwave generator 28.

15 While certain exemplary embodiments have been described and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention not be limited to the specific constructions and arrangements shown and
20 described, since various other modifications may occur to those ordinarily skilled in the art.